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(54) PHOTOVOLTAIC INVERTER SYSTEM, POTENTIAL INDUCED DEGRADATION EFFECT COMPENSATION METHOD AND DEVICE FOR THE SAME

FOTOVOLTAISCHES WECHSELRICHTERSYSTEM, POTENZIALINDUZIERTER ABBAU DURCH WIRKUNGSKOMPENSATIONSVERFAHREN UND VORRICHTUNG DAFÜR

SYSTÈME D'ONDULEUR PHOTOVOLTAÏQUE, PROCÉDÉ DE COMPENSATION D'EFFET DE DÉGRADATION INDUITE DE POTENTIEL ET DISPOSITIF CORRESPONDANT

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Description

FIELD

[0001] The present disclosure relates to the technical field of potential induced degradation (PID) effect compensation, and in particular to a photovoltaic inverter system, and a PID effect compensation device and a PID effect compensation method for the photovoltaic inverter system.

BACKGROUND

[0002] A potential induced degradation (PID) effect refers to a phenomenon that an output performance of a photovoltaic module is degraded when an output terminal of the photovoltaic module (i.e., a string input of a photovoltaic inverter system) suffers a high negative bias voltage relative to a metal frame of the photovoltaic module. The PID effect is characterized in reducing of an open-circuit voltage, a short-circuit current and a fill factor of the module. In recent years, with fast development of a photovoltaic grid-connection power generation system, a string input voltage configuration of the photovoltaic inverter system is higher and higher, and a system of 1500V is spread and applied gradually. Since the metal frame of the photovoltaic module is generally grounded, under a high string input voltage, a high negative bias voltage is formed between a battery panel and the grounded metal frame in a photovoltaic module close to a negative electrode terminal of the string, such that charges transfer occurs, and a surface of the module is polarized. The photovoltaic module closer to the negative electrode terminal of the string has more obvious polarization (as shown in Figure 1). Under the negative bias voltage for a long period, particularly in a high temperature and high humidity condition, a serious PID effect will occur in the photovoltaic module, resulting in reducing of a power generation capacity of the system year by year.

[0003] The current photovoltaic module manufacturer prevents the PID effect of the module mainly by using packing materials with high performances, which has a high cost and is not adaptive to a built photovoltaic power station. For a built photovoltaic system, the PID effect is prevented normally by a solution of grounding of a negative electrode of the photovoltaic string or a solution of raising a potential of a virtual neutral point at an alternating current (AC) power grid side. In the solution of grounding of the negative electrode of the photovoltaic string, the negative electrode of the photovoltaic string is directly grounded, such that potentials to ground of series-connected battery panels in the string are always positive bias voltages, thereby preventing PID effects. In the solution of raising a potential of the virtual neutral point at the AC power grid side, a potential to ground of the virtual neutral point at the AC side is raised by an external direct current source, such that a potential to ground of a neutral point of a direct current input bus is raised, thereby indirectly raising a potential to ground of the negative electrode of the input module above a zero potential. However, the solution is only adaptive to a case that the inverter is grid-connected.

[0004] The PID effect reduces a power generation capacity of the photovoltaic battery panel, and a cost of the conventional PID effect preventing solution is high. The above two solutions for the PID effect can only prevent the PID effect to a certain degree and cannot repair the photovoltaic module in which the PID effect occurs.

[0005] CN 104393833 A and US 2017/0271878 A1 describe a photovoltaic intelligent power supply, CN 204167913 U describes an anti-PID apparatus for an inverter, CN 104300584 A describes an anti-PID method with high security, and CN 103475208 A describes an anti-PID circuit of a photovoltaic system. All the above technologies apply the technical solution of connecting a positive voltage power supply between the two electrodes of the photovoltaic string, so as to directly compensate PID charges, or between the negative electrode of the photovoltaic strings and ground, therefore raising the potential of the negative electrode of the photovoltaic strings.

SUMMARY

[0006] A photovoltaic inverter system, a PID effect compensation device and a PID effect compensation method for the photovoltaic inverter system are provided according to the present disclosure, so as to solve problems in the conventional technology that a cost is high and a photovoltaic module in which a PID effect occurs cannot be repaired. In particular the photovoltaic inverter system, the PID effect compensation device and the PID effect compensation method for the photovoltaic inverter system are provided according to the present disclosure, so as to contribute to perform the PID compensation at a suitable application environment, and contribute to prevent a risk of damage caused by short-circuit in particular of an output terminal of an isolation AC/DC conversion unit.

[0007] In order to achieve the above object, technical solutions according to the present disclosure are as follows.

[0008] A potential induced degradation (PID) effect compensation method for a photovoltaic inverter system is provided, which is applied to a PID effect compensation method device for the photovoltaic inverter system, where the PID effect compensation device for the photovoltaic inverter system includes a direct current voltage sampling unit, a processing control unit, an isolation alternating-current/direct-current (AC/DC) conversion unit and a switching protection unit, and the PID effect compensation method includes:

outputting, by the direct current voltage sampling unit, a direct current voltage signal to the processing control unit;

determining, by the processing control unit, whether a PID effect compensation condition is met based on the direct current voltage signal;

calculating, by the processing control unit, a compensation voltage to be outputted by the isolation AC/DC conversion unit based on the recorded direct current voltage signal, if the PID effect compensation condition is met; and

controlling, by the processing control unit, the isolation AC/DC conversion unit to apply the compensation voltage to positive electrode terminals of photovoltaic modules and ground via the switching protection unit, to perform PID effect compensation on the photovoltaic modules.

[0009] The switching protection unit includes a protection resistor and a fling-cut switch, and the calculating, by the processing control unit, a compensation voltage to be outputted by the isolation AC/DC conversion unit based on the recorded direct current voltage signal includes:

calculating, by the processing control unit, a PID effect accumulation value of the photovoltaic modules during daytime based on a value and an acting duration of the recorded direct current voltage signal, wherein the acting duration is a duration when the direct current voltage signal is greater than the preset voltage;

calculating a minimum compensation voltage for the positive electrode terminals of the photovoltaic modules based on the PID effect accumulation value and a preset compensation parameter, where the preset compensation parameter may include a compensation time and a

difference between a nighttime compensation accumulation value and the PID effect accumulation value; and

calculating the compensation voltage to be outputted by the isolation AC/DC conversion unit, based on the minimum compensation voltage and a voltage division relation between the protection resistor and the total equivalent insulation impedance to ground of the photovoltaic modules.

[0010] Preferably, the determining, by the processing control unit, whether a PID effect compensation condition is met based on the direct current voltage signal may include:

determining, by the processing control unit, whether the direct current voltage signal is greater than a preset voltage;

determining, by the processing control unit, that it is daytime, if the direct current voltage signal is greater than the preset voltage; and
determining, by the processing control unit, that it is nighttime and the PID effect compensation condition is met, if the direct current voltage signal is less than or equal to the preset voltage.

[0011] Preferably, the outputting, by the direct current voltage sampling unit, a direct current voltage signal to the processing control unit may include:
outputting, by the direct current voltage sampling unit, only a maximum output voltage among output voltages of all the photovoltaic modules as the direct current voltage signal, to the processing control unit.

[0012] Preferably, before the calculating, by the processing control unit, a compensation voltage to be outputted by the isolation AC/DC conversion unit based on the recorded direct current voltage signal, the method may further include:

determining, by the processing control unit, whether a total equivalent insulation impedance to ground of the photovoltaic module is greater than a preset impedance, if the PID effect compensation condition is met; and

outputting, by the processing control unit, an alarm signal, if the total equivalent insulation impedance to ground of the photovoltaic modules is less than or equal to the preset impedance, where

the step of calculating, by the processing control unit, the compensation voltage to be outputted by the isolation AC/DC conversion unit based on the recorded direct current voltage signal is performed if the total equivalent insulation impedance to ground of the photovoltaic modules is greater than the preset impedance.

[0013] A PID effect compensation device for a photovoltaic inverter system is provided, which includes a direct current voltage sampling unit, a processing control unit, an isolation AC/DC conversion unit and a switching protection unit, where

input terminals of the direct current voltage sampling unit are connected to output terminals of photovoltaic modules, the direct current voltage sampling unit is configured to output a direct current voltage signal to the processing control unit;

an input terminal of the processing control unit is connected to an output terminal of the direct current voltage sampling unit, output terminals of the processing control unit are respectively connected to a control terminal of the switching protection unit and a control terminal of the isolation AC/DC conversion unit, the processing control unit is configured to determine whether a PID effect compensation condition is met based on the direct current voltage signal, and calculate a compensation voltage to be outputted by the isolation AC/DC conversion unit based on the recorded direct current voltage signal if the PID effect compensation condition is met;

an input terminal of the isolation AC/DC conversion unit is connected to a power grid and an output terminal of the isolation AC/DC conversion unit is connected to an input terminal of the switching protection unit; the isolation AC/DC conversion unit is configured to output the compensation voltage under control of the processing control unit; and

output terminals of the switching protection unit are connected to positive electrode terminals of the photovoltaic modules, and the switching protection unit is configured to transfer the compensation voltage to apply the compensation voltage between the positive electrode terminals of the photovoltaic modules and ground, to perform PID effect compensation on the photovoltaic modules.

[0014] The switching protection unit includes a protection resistor and a fling-cut switch, and the processing control unit is configured to:

calculate a PID effect accumulation value of the photovoltaic modules during daytime based on a value and an acting duration of the recorded direct current voltage signal, wherein the acting duration is a duration when the direct current voltage signal is greater than the preset voltage;

calculate a minimum compensation voltage for the positive electrode terminals of the photovoltaic modules based on the PID effect accumulation value and a preset compensation parameter, where the preset compensation parameter may include a compensation time and a difference between a nighttime compensation accumulation value and the PID effect accumulation value; and

calculate the compensation voltage to be outputted by the isolation AC/DC conversion unit, based on the minimum compensation voltage and a voltage division relation between the protection resistor and the total equivalent insulation impedance to ground of the photovoltaic modules.

[0015] Preferably, the direct current voltage sampling unit may include a set of connected diodes with a common cathode and a set of connected diodes with a common anode, where

anodes of the set of connected diodes with the common cathode are connected to the positive electrode terminals of the photovoltaic modules in one-to-one correspondence;

cathodes of the set of connected diodes with the common anode are connected to negative electrode terminals of the photovoltaic modules in one-to-one correspondence; and

a common cathode connected point of the set of connected diodes with the common cathode and a common anode connection point of the set of connected diodes with the common anode are two output terminals of the direct current voltage sampling unit.

[0016] Preferably, the switching protection unit may include a protection resistor, a fling-cut switch and a set of connected diodes with a common anode, where

a control terminal of the fling-cut switch is the control terminal of the switching protection unit;

the protection resistor and the fling-cut switch are connected in series to form a series branch, one end of the series branch serves as the input terminal of the switching protection unit and the other end of the series branch is connected to a common anode connection point of the set of connected diodes with the common anode; and

cathodes of the set of connected diodes with the common anode are connected to the positive electrode terminals of the photovoltaic modules in one-to-one correspondence.

[0017] Preferably, a direct current output positive electrode terminal of the isolation AC/DC conversion unit may be connected to the switching protection unit; and
a direct current output negative electrode terminal of the isolation AC/DC conversion unit may be grounded.

[0018] A photovoltaic inverter system is provided, which includes a power conversion device, a filtering device and the PID effect compensation device descried above, where

an input terminal of the power conversion device is connected to a photovoltaic module;

an output terminal of the power conversion device is connected to an input terminal of the filtering device; and

an output terminal of the filtering device is connected to a power grid.

[0019] With the PID effect compensation method of the photovoltaic inverter system according to the present disclosure, the direct current voltage sampling unit outputs the direct current voltage signal to the processing control unit; the processing control unit determines whether the PID effect compensation condition is met based on the direct current voltage signal; if the PID effect compensation condition is met, the processing control unit calculates a compensation voltage to be outputted by the isolation AC/DC conversion unit based on the recorded direct current voltage signal; and the processing control unit controls the isolation AC/DC conversion unit to apply the compensation voltage between the positive electrode terminals of the photovoltaic module and ground via the switching protection unit, to perform PID effect compensation on the photovoltaic modules. That is, the processing control unit records operation conditions of the photovoltaic modules, determines whether the PID effect compensation condition is met, calculates the compensation voltage optimally and controls the PID effect compensation device to perform PID effect compensation on the photovoltaic modules. By performing the PID effect compensation and repair, a problem of degradation of the photovoltaic modules in the photovoltaic power station can be effectively solved to improve the power generation capacity of the system. As compared with the conventional technology, the solution according to the present disclosure has a high operation reliability and a low maintenance cost.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] In order to illustrate technical solutions in embodiments of the present disclosure or the conventional technology more clearly, drawings for the description of the embodiments or the conventional technology are introduced simply hereinafter. Apparently, the drawings described in the following only describe some embodiments of the present disclosure. Other drawings may be obtained according these drawings by those skilled in the art without any creative work.

Figure 1 is a schematic diagram of polarization of a photovoltaic module;

Figure 2 is a schematic structural diagram of a photovoltaic inverter system according to an embodiment of the present disclosure;

Figure 3 is a flowchart of a PID effect compensation method for a photovoltaic inverter system according to another embodiment of the present disclosure;

Figure 4 is a flowchart of another PID effect compensation method for a photovoltaic inverter system according to another embodiment of the present disclosure;

Figure 5 is a flowchart of another PID effect compensation method for a photovoltaic inverter system according to another embodiment of the present disclosure;

Figure 6 is a schematic structural diagram of a PID effect compensation solution according to the conventional technology; and

Figure 7 is a schematic structural diagram of another photovoltaic inverter system according to another embodiment of the present disclosure.

DETAILED DESCRIPTION OF EMBODIMENTS

[0021] In order to make the above objects, features and advantages of the present disclosure become more obvious and easier to be understood, embodiments of the present disclosure are illustrated in detail in conjunction with the drawings hereinafter.

[0022] A photovoltaic inverter system, and a PID effect compensation device and a PID effect compensation method for the photovoltaic inverter system are provided according to the present disclosure, so as to solve problems in the conventional technology that a cost is high and a photovoltaic module in which a PID effect occurs cannot be repaired.

[0023] The PID effect compensation method for a photovoltaic inverter system is applied to a PID effect compensation device for the photovoltaic inverter system. As shown in Figure 2, the PID effect compensation device for the photovoltaic inverter system includes: a direct current voltage sampling unit 101, a processing control unit 102, an isolation AC/DC conversion unit 103 and a switching protection unit 104. As shown in Figure 3, the PID effect compensation method for the photovoltaic inverter system includes steps S101 to S104 in the following.

[0024] In step S101, the direct current voltage sampling unit outputs a direct current voltage signal to the processing control unit.

[0025] The direct current voltage signal can represent an output capability of a photovoltaic module at a current time, such that the processing control unit determines whether a PID effect compensation condition is met currently based on the direct current voltage signal.

[0026] In step S102, the processing control unit determines whether the PID effect compensation condition is met based on the direct current voltage signal.

[0027] In practices, the PID effect compensation condition may be set according to a specific application environment. For example, the condition may be, at a time suitable to perform PID effect compensation on a photovoltaic power station, performing the PID effect compensation and repair on photovoltaic modules with suitable compensation parameters. The condition is not limited herein, and any possible conditions fall within the scope of protection of the present disclosure.

[0028] Step S103 is performed if the PID effect compensation condition is met.

[0029] In step S103, the processing control unit calculates a compensation voltage to be outputted by the isolation AC/DC conversion unit based on the recorded direct current voltage signal.

[0030] The processing control unit records the received direct current voltage signal in a real-time manner, and calculates the compensation voltage, i.e., the suitable compensation parameters described above, based on the recorded direct current voltage signal.

[0031] The isolation AC/DC conversion unit acquires power from a power grid and performs isolation conversion, so as to perform PID effect compensation with the calculated compensate voltage based on the corresponding direct current voltage signal. For different direct current voltage signals, the compensate voltages are different, that is, the PID effect compensation and repair is performed with respect to different degradation of photovoltaic modules.

[0032] In step S104, the processing control unit controls the isolation AC/DC conversion unit to apply the compensation voltage between positive electrode terminals of photovoltaic modules and ground via the switching protection unit, to perform PID effect compensation on the photovoltaic modules.

[0033] After calculating the suitable compensation voltage, the processing control unit controls the switching protection unit to form a path between the isolation AC/DC conversion unit and the positive electrode terminals of the photovoltaic modules to transfer the compensation voltage, thereby performing the PID effect compensation and repair.

[0034] With the PID effect compensation method of the photovoltaic inverter system according to the embodiment, the processing control unit records operation conditions of the photovoltaic modules, determines whether the PID effect compensation condition is met, calculates the compensation voltage optimally and controls the PID effect compensation device to perform the PID effect compensation on the photovoltaic modules. By performing the PID effect compensation and repair, the problem of degradation of the photovoltaic modules in the photovoltaic power station can be effectively solved to improve the power generation capacity of the system. As compared with the conventional technology, the solution according to the embodiment has a low operation and maintenance cost. In addition, the PID effect compensation is performed on the photovoltaic modules based on the calculated compensation voltage, thereby improving reliability of the compensation.

[0035] Another PID effect compensation method for a photovoltaic inverter system is provided according to another embodiment of the present disclosure. As shown in Figure 4, the method includes step S201 to step S204 in the following.

[0036] In step S201, a direct current voltage sampling unit outputs a maximum output voltage among output voltages of all photovoltaic modules as a direct current voltage signal, to a processing control unit.

[0037] In step S202, the processing control unit determines whether the direct current voltage signal is greater than a preset voltage.

[0038] The processing control unit determines that it is daytime, if the direct current voltage signal is greater than the preset voltage. The processing control unit determines that it is nighttime and a PID effect compensation condition is met, if the direct current voltage signal is less than or equal to the preset voltage, in which case, step S203 is performed.

[0039] In step S203, the processing control unit calculates a compensation voltage to be outputted by an isolation AC/DC conversion unit based on the recorded direct current voltage signal.

[0040] In step S204, the processing control unit controls the isolation AC/DC conversion unit to apply the compensation voltage between positive electrode terminals of photovoltaic modules and ground via a switching protection unit, to perform PID effect compensation on the photovoltaic modules.

[0041] With the PID effect compensation method for the photovoltaic inverter system according to the embodiment, the maximum output voltage among the output voltages of all the photovoltaic modules is obtained in step S201. Therefore, only the maximum output voltage of all the photovoltaic modules is sampled in the embodiment, such that a sampling circuit is simplified greatly and AD sampling port resources of the processing control unit is saved.

[0042] With the step S202, the photovoltaic power station can perform normal inverter power generation during daytime and record direct current voltage signals of the photovoltaic modules in a real-time manner. Once it is determined as nightlight based on the direct current voltage signal, degradation of the photovoltaic modules due to PID effects caused by normal power generation during daytime can be compensated and repaired.

[0043] In practices, the preset voltage may be adjusted according to a specific application environment of the photovoltaic power station, that is, the preset voltage may be adjusted according to seasons or other environmental conditions, the implementations of which are not limited herein and all fall within the scope of the protection of the present disclosure.

[0044] Another PID effect compensation method for a photovoltaic inverter system is further provided according to another embodiment of the present disclosure. Based on Figure 3 or Figure 4, in a PID effect compensation device to which the method is applied, the switching protection unit includes a protection resistor and a fling-cut switch. As shown in Figure 5 (which is illustrated based on Figure 4 as an example), the method includes steps S301 to S308 in the following.

[0045] In step S301, a direct current voltage sampling unit outputs a maximum output voltage among output voltages of all photovoltaic modules as a direct current voltage signal to a processing control unit.

[0046] In step S302, the processing control unit determines whether the direct current voltage signal is greater than a preset voltage.

[0047] The processing control unit determines that it is daytime if the direct current voltage signal is greater than the preset voltage. The processing control unit determines that it is nighttime and a PID effect compensation condition is met if the direct current voltage signal is less than or equal to the preset voltage, in which case, step S303 is performed.

[0048] In step S303, the processing control unit determines whether a total equivalent insulation impedance to ground of the photovoltaic modules is greater than a preset impedance.

[0049] Step S304 is performed if the total equivalent insulation impedance to ground of the photovoltaic modules is less than or equal to the preset impedance (or it is shorted).

[0050] In step S304, the processing control unit outputs an alarm signal.

[0051] Step S305 is performed if the total equivalent insulation impedance to ground of the photovoltaic modules is greater than the preset impedance.

[0052] In step S305, the processing control unit calculates a PID effect accumulation value of the photovoltaic modules during daytime based on a value and an acting duration of the recorded direct current voltage signal.

[0053] In step S306, a minimum compensation voltage for the positive electrode terminals of the photovoltaic modules is calculated based on the PID effect accumulation value and a preset compensation parameter. The preset compensation parameter includes a compensation time and a difference between a nighttime compensation accumulation value and the PID effect accumulation value.

[0054] In step S307, a compensation voltage to be outputted by an isolation AC/DC conversion unit is calculated based on the minimum compensation voltage and a voltage division relation between a protection resistor and the total equivalent insulation impedance to ground of the photovoltaic modules.

[0055] In step S308, the processing control unit controls the isolation AC/DC conversion unit to apply the compensation voltage between positive electrode terminals of the photovoltaic modules and ground via a switching protection unit (by turning on the fling-cut switch), to perform PID effect compensation on the photovoltaic modules.

[0056] In the conventional technology, there is a method for preventing a PID effect of a photovoltaic battery panel. In the method, potentials to ground of negative electrodes (PV1-, PV2-, ..., PVn-) of various photovoltaic strings are raised by using a high frequency switch power supply, to perform PID effects compensation and repair (as shown in Figure 6). However, a high voltage fuse (F1, F2, ..., Fn) needs to be connected in series between an output positive electrode terminal of the high frequency switch power supply and each photovoltaic string, so as to prevent a risk of damage caused by a short-circuit of the output of the high frequency switch power supply due to that a negative electrode of a photovoltaic string is shorted to ground. When short-circuit occurs, it is required to replace the fuse on site. In addition, in the solution, sampling needs to be performed on the voltage of each photovoltaic string (voltage sampling of a battery 1, voltage sampling of a battery 2, ..., voltage sampling of a battery n), and therefore a cost of implementation and maintenance is relatively high. Furthermore, in the conventional PID repair control method, the potential to ground of the module is raised by only applying a fixed voltage inflexibly, without optimizing an amplitude and application time of the compensation voltage.

[0057] In the PID effect compensation method of the photovoltaic inverter system according to the embodiment, the switching protection unit includes the protection resistor and the fling-cut switch. The protection resistor can effectively prevent a risk of damage caused by short-circuit of the output terminal of the isolation AC/DC conversion unit due to that a positive electrode terminal of a photovoltaic module is shorted to ground. Furthermore, after the photovoltaic module is recovered from the shorted state, all components of the switching protection unit are not damaged and do not need to be replaced and maintained.

[0058] Furthermore, in the PID effect compensation method of the photovoltaic inverter system according to the embodiment, the maximum output voltage among the output voltages of all the photovoltaic modules is obtained in step S301. Therefore, only the maximum output voltage of all the photovoltaic modules is required to be sampled, such that the sampling circuit is greatly simplified, and the AD sampling port resources of the processing control unit are saved, which leads to a low implementation cost.

[0059] In addition, with the PID effect compensation method of the photovoltaic inverter system according to the embodiment, by performing the steps S305 to step S307, an amplitude and application time of a raising voltage outputted by the compensation device are optimized according to an operation condition record of the inverter during daytime in combination with the equivalent insulation impedance to ground of the battery panel, thereby performing the optimal PID effect repair on the photovoltaic modules.

[0060] A PID effect compensation device for a photovoltaic inverter system is further provided according to another embodiment of the present disclosure. As shown in Figure 2, the device includes: a direct current voltage sampling unit 101, a processing control unit 102, an isolation AC/DC conversion unit 103 and a switching protection unit 104.

[0061] Input terminals of the direct current voltage sampling unit 101 are connected to output terminals of photovoltaic modules. The direct current voltage sampling unit 101 is configured to output a direct current voltage signal to the processing control unit 102.

[0062] An input terminal of the processing control unit 102 is connected to an output terminal of the direct current voltage sampling unit 101, and output terminals of the processing control unit 102 are respectively connected to a control terminal of the switching protection unit 104 and a control terminal of the isolation AC/DC conversion unit 103. The processing control unit 102 is configured to determine whether a PID effect compensation condition is met based on the direct current voltage signal, and calculate a compensation voltage to be outputted by the isolation AC/DC conversion unit 103 based on the recorded direct current voltage signal, if the PID effect compensation condition is met.

[0063] An input terminal of the isolation AC/DC conversion unit 103 is connected to a power grid, and an output terminal of the isolation AC/DC conversion unit 103 is connected to the input terminal of the switching protection unit 104. The isolation conversion unit 103 is configured to output the compensation voltage under control of the processing control unit 102.

[0064] Output terminals of the switching protection unit 104 are connected to positive electrode terminals of the photovoltaic modules. The switching protection unit 104 is configured to transfer the compensation voltage to the positive electrode terminals of the photovoltaic modules, to perform PID effect compensation on the photovoltaic modules.

[0065] With the PID effect compensation device for the photovoltaic inverter system according to the embodiment, the processing control unit records operation conditions of the photovoltaic modules and determines whether the PID effect compensation condition is met, calculates the compensation voltage optimally and controls the integrated PID effect compensation device to perform the PID effect compensation on the photovoltaic modules. By performing the PID effect compensation and repair, the problem of degradation of the photovoltaic modules in the photovoltaic power station can be effectively solved to improve the power generation capacity of the system. As compared with the conventional technical solution, the solution according to the embodiment has a high operation reliability and a low maintenance cost.

[0066] In practices, the PID effect compensation device for the photovoltaic inverter system may be an integrated device, the implementations of which are not limited here and all falls within the scope of protection of the present disclosure.

[0067] Preferably, as shown in Figure 7, the direct current voltage sampling unit 101 includes: a set of connected diodes with a common cathode and a set of connected diodes with a common anode.

[0068] Anodes of the set of connected diodes with the common cathode are connected to positive electrode terminals of photovoltaic modules in one-to-one correspondence.

[0069] Cathodes of the set of connected diodes with the common anode are connected to negative electrode terminals of the photovoltaic modules in one-to-one correspondence; and

[0070] A common cathode connection point of the set of connected diodes with the common cathode and a common anode connection point of the set of connected diodes with the common anode are two output terminals of the direct current voltage sampling unit 101.

[0071] When any one of the photovoltaic modules has a voltage with a maximum amplitude, corresponding diodes connected to a positive electrode terminal and a negative electrode terminal of the photovoltaic module conduct, thereby obtaining a maximum voltage Upv of n (n is a positive integer greater than or equal to 1) input strings. Therefore, in the embodiment, only a voltage obtained after performing "wired-AND" of positive electrodes and negative electrodes of strings needs to be sampled, such that the sampling circuit is greatly simplified and the AD sampling portion resources of the processing control unit are saved.

[0072] Preferably, as shown in Figure 7, the switching protection unit 104 includes: a protection resistor R1, a fling-cut switch S1 and a set of connected diodes with a common anode.

[0073] A control terminal of the fling-cut switch S1 is a control terminal of the switching protection unit 104.

[0074] The protection resistor R1 and the fling-cut switch are connected in series to form a series branch. One end of the series branch serves as the input terminal of the switching protection unit 104 and the other end of the series branch is connected to a common anode connection point of the set of connected diodes with the common anode.

[0075] Cathodes of the set of connected diodes with the common anode are connected to positive electrode terminals of the photovoltaic modules in one-to-one correspondence.

[0076] The controlled fling-cut switch S1 may be a switch, a relay or a semiconductor fling-cut switch. The protection resistor R1 can effectively prevent a risk of damage caused by short-circuit of the output terminal of the isolation AC/DC conversion unit 103 due to that a positive electrode terminal of a string is shorted to ground. After the external string is recovered from a short-circuit state, all components of the switching protection unit 104 are not damaged and do not need to be replaced and maintained.

[0077] With respect to the switching protection unit 104 shown in Figure 7, the calculation of the compensation voltage to be outputted by the isolation AC/DC conversion unit 103 performed by the processing control unit 102 is described as follows. A PID effect accumulation value of the photovoltaic modules during daytime is calculated based on a value of an acting duration of the recorded direct current voltage signal. Then a minimum compensation voltage for the positive electrode terminals of the photovoltaic modules is calculated based on the PID effect accumulation value and a preset compensation parameter, i.e., a voltage to ground at a point A in Figure 7. The preset compensation parameter includes a compensation time and a difference between a nighttime compensation accumulation value and the PID effect accumulation value. In practices, the difference may be set according to a specific application environment such that the nighttime compensation accumulation value is greater than the PID effect accumulation value. Then a compensation voltage to be outputted by the isolation AC/DC conversion unit is calculated based on the minimum compensation voltage and a voltage division relation between the protection resistor R1 and the total equivalent insulation impedance to ground of the photovoltaic modules.

[0078] Preferably, as shown in Figure 7, a direct current output positive electrode terminal of the isolation AC/DC conversion unit 103 is connected to the switching protection unit 104.

[0079] A direct current output negative terminal of the isolation AC/DC conversion unit 103 is grounded.

[0080] The operation principles are the same as that of the above embodiments, which are not described in detail here.

[0081] It should be noted that, the PID effect compensation device for the photovoltaic inverter system may be an integrated device, the implementations of which are not limited here and all fall within the scope of protection of the present disclosure.

[0082] A photovoltaic inverter system is further provided according to another embodiment. As shown in Figure 2 or Figure 7, the photovoltaic inverter system includes: a power conversion device 200, a filtering device 300 and a PID effect compensation device 400 according to any of the above embodiments.

[0083] An input terminal of the power conversion device 200 is connected to a photovoltaic module. An output terminal of the power conversion device 200 is connected to an input terminal of the filtering device 300.

[0084] An output terminal of the filtering device 300 is connected to a power grid.

[0085] Connection relation of components and operation principles are the same as that of the above embodiments, which are not described in detail here.

[0086] Various embodiments of the present disclosure are described in a progressive manner, and each embodiment lays emphasis on differences from other embodiments. For the same or similar parts between the embodiments, one may refer to description of other embodiments. For the device disclosed by the embodiment, since the device corresponds to the method disclosed by the above embodiments, the description of the device is simple. For the part of the device related to the method, one may refer to the description of the method embodiments.

Claims

1. A potential induced degradation, PID, effect compensation method for a photovoltaic inverter system, applied to a PID effect compensation device for the photovoltaic inverter system, wherein the PID effect compensation device for the photovoltaic inverter system comprises a direct current voltage sampling unit (101), a processing control unit (102), an isolation AC/DC conversion unit (103) and a switching protection unit (104), and the PID effect compensation method comprises:

   outputting (S101), by the direct current voltage sampling unit (101), a direct current voltage signal to the processing control unit (102);
   determining (S102), by the processing control unit (102), whether a PID effect compensation condition is met based on the direct current voltage signal;
   calculating (S103), by the processing control unit (102), a compensation voltage to be outputted by the isolation alternating-current/direct-current, AC/DC, conversion unit (103) based on the recorded direct current voltage signal, if the PID effect compensation condition is met; and
   controlling (S104), by the processing control unit (102), the isolation AC/DC conversion unit (103) to apply the compensation voltage between positive electrode terminals of photovoltaic modules and ground via the switching protection unit (104), to perform PID effect compensation on the photovoltaic modules;
   and **characterised by**:

      the switching protection unit (104) comprises a protection resistor and a fling-cut switch, and
      the calculating (S103), by the processing control unit (102), a compensation voltage to be outputted by the isolation AC/DC conversion unit (103) based on the recorded direct current voltage signal comprises:

         calculating (S305), by the processing control unit (102), a PID effect accumulation value of the photovoltaic modules during daytime based on a value and an acting duration of the recorded direct current voltage signal, wherein the acting duration is a duration when the direct current voltage signal is greater than a preset voltage;
         calculating (S306) a minimum compensation voltage for the positive electrode terminals of the photovoltaic modules based on the PID effect accumulation value and a preset compensation parameter, wherein the preset compensation parameter comprises a compensation time and a difference between a nighttime compensation accumulation value and the PID effect accumulation

value; and
calculating (S307) the compensation voltage to be outputted by the isolation AC/DC conversion unit (103), based on the minimum compensation voltage and a voltage division relation between the protection resistor and the total equivalent insulation impedance to ground of the photovoltaic modules.

2. The PID effect compensation method for a photovoltaic inverter system according to claim 1, wherein the determining (S102), by the processing control unit (102), whether a PID effect compensation condition is met based on the direct current voltage signal comprises:

determining (S302), by the processing control unit (102), whether the direct current voltage signal is greater than the preset voltage;
determining, by the processing control unit (102), that it is daytime, if the direct current voltage signal is greater than the preset voltage; and
determining, by the processing control unit (102), that it is nighttime and the PID effect compensation condition is met, if the direct current voltage signal is less than or equal to the preset voltage.

3. The PID effect compensation method for a photovoltaic inverter system according to claim 1 or 2, wherein before the calculating (S103), by the processing control unit (102), a compensation voltage to be outputted by the isolation AC/DC conversion unit (103) based on the recorded direct current voltage signal, the PID effect compensation method further comprises:

determining (S303), by the processing control unit (102), whether a total equivalent insulation impedance to ground of the photovoltaic modules is greater than a preset impedance, if the PID effect compensation condition is met; and
outputting (S304), by the processing control unit (102), an alarm signal, if the total equivalent insulation impedance to ground of the photovoltaic modules is less than or equal to the preset impedance, wherein
the step of calculating (S103), by the processing control unit (102), the compensation voltage to be outputted by the isolation AC/DC conversion unit (103) based on the recorded direct current voltage signal is performed if the total equivalent insulation impedance to ground of the photovoltaic modules is greater than the preset impedance.

4. A potential induced degradation, PID, effect compensation device for a photovoltaic inverter system, comprising
a direct current voltage sampling unit (101),
a processing control unit (102),
an isolation alternating-current/direct-current, AC/DC, conversion unit (103), and
a switching protection unit (104), wherein:

input terminals of the direct current voltage sampling unit (101) are connected to output terminals of photovoltaic modules, the direct current voltage sampling unit (101) is configured to output a direct current voltage signal to the processing control unit (102);
an input terminal of the processing control unit (102) is connected to an output terminal of the direct current voltage sampling unit (101), output terminals of the processing control unit are respectively connected to a control terminal of the switching protection unit (104) and a control terminal of the isolation AC/DC conversion unit (103), the processing control unit (102) is configured to determine whether a PID effect compensation condition is met based on the direct current voltage signal, and calculate a compensation voltage to be outputted by the isolation AC/DC conversion unit (103) based on the recorded direct current voltage signal if the PID effect compensation condition is met;
an input terminal of the isolation AC/DC conversion unit (103) is connected to a power grid, and an output terminal of the isolation AC/DC conversion unit (103) is connected to an input terminal of the switching protection unit (104), the isolation AC/DC conversion unit (103) is configured to output the compensation voltage under control of the processing control unit (102); and
output terminals of the switching protection unit (104) are connected to positive electrode terminals of the photovoltaic modules, and the switching protection unit (104) is configured to transfer the compensation voltage to apply the compensation voltage between the positive electrode terminals of the photovoltaic modules and ground, to perform PID effect compensation on the photovoltaic modules;
and **characterised by**:

the switching protection unit (104) comprises a protection resistor and a fling-cut switch, and
the processing control unit (102) is configured to:

calculate a PID effect accumulation value of the photovoltaic modules during daytime based on a value and an acting duration of the recorded direct current

voltage signal, wherein the acting duration is a duration when the direct current voltage signal is greater than a preset voltage;
calculate a minimum compensation voltage for the positive electrode terminals of the photovoltaic modules based on the PID effect accumulation value and a preset compensation parameter, wherein the preset compensation parameter comprises a compensation time and a difference between a nighttime compensation accumulation value and the PID effect accumulation value; and
calculate the compensation voltage to be outputted by the isolation AC/DC conversion unit (103), based on the minimum compensation voltage and a voltage division relation between the protection resistor and the total equivalent insulation impedance to ground of the photovoltaic modules.

5. The PID effect compensation device for a photovoltaic inverter system according to claim 4, wherein the direct current voltage sampling unit (101) comprises a set of connected diodes with a common cathode and a set of connected diodes with a common anode;
anodes of the set of connected diodes with the common cathode are connected to the positive electrode terminals of the photovoltaic modules in one-to-one correspondence;
cathodes of the set of connected diodes with the common anode are connected to negative electrode terminals of the photovoltaic modules in one-to-one correspondence; and
a common cathode connection point of the set of connected diodes with the common cathode and a common anode connection point of the set of connected diodes with the common anode are two output terminals of the direct current voltage sampling unit (101).

6. The PID effect compensation device for a photovoltaic inverter system according to claim 4, wherein the switching protection unit (104) comprises a protection resistor R1, a fling-cut switch S1 and a set of connected diodes with a common anode;
a control terminal of the fling-cut switch S1 is the control terminal of the switching protection unit (104);
the protection resistor R1 and the fling-cut switch S1 are connected in series to form a series branch, one end of the series branch serves as the input terminal of the switching protection unit (104) and the other end of the series branch is connected to a common anode connection point of the set of connected diodes with the common anode; and
cathodes of the set of connected diodes with the common anode are connected to the positive electrode terminals of the photovoltaic modules in one-to-one correspondence.

7. The PID effect compensation device for a photovoltaic inverter system according to claim 4, wherein a direct current output positive electrode terminal of the isolation AC/DC conversion unit (103) is connected to the switching protection unit; and
a direct current output negative electrode terminal of the isolation AC/DC conversion unit (103) is grounded.

8. A photovoltaic inverter system, comprising
a power conversion device (200),
a filtering device (300), and
the potential induced degradation, PID, effect compensation device (400) according to any one of claims 4 to 7, wherein
an input terminal of the power conversion device is connected to a photovoltaic module;
an output terminal of the power conversion device is connected to an input terminal of the filtering device; and
an output terminal of the filtering device is connected to a power grid.

9. The PID effect compensation method for a photovoltaic inverter system according to claim 1, wherein the outputting (S101), by the direct current voltage sampling unit (101), a direct current voltage signal to the processing control unit (102) comprises:
outputting (S201), by the direct current voltage sampling unit (101), only a maximum output voltage among output voltages of all the photovoltaic modules as the direct current voltage signal, to the processing control unit (102).

Patentansprüche

1. Verfahren zur Kompensation eines potentialinduzierten Abbaueffekts bzw. PID-Effekts für ein fotovoltaisches Wechselrichtersystem, das an einer PID-Effekt-Kompensationsvorrichtung für das fotovoltaische Wechselrichtersystem zur Anwendung kommt, wobei die PID-Effekt-Kompensationsvorrichtung für das fotovoltaische Wechselrichtersystem eine Gleichspannungsabtasteinheit (101), eine Prozesssteuerungseinheit (102), eine Trennungs-AC/DC-Umwandlungseinheit (103) und eine Umschaltschutzeinheit (104) aufweist und das PID-Effekt-Kompensationsverfahren umfasst:

Ausgeben (S101), durch die Gleichspannungsabtasteinheit (101), eines Gleichspannungssig-

nals an die Prozesssteuerungseinheit (102);
Bestimmen (S102), durch die Prozesssteuerungseinheit (102) auf Grundlage des Gleichspannungssignals, ob eine PID-Effekt-Kompensationsbedingung erfüllt ist;
Berechnen (S103), durch die Prozesssteuerungseinheit (102), einer durch die Trennungs-Wechselstrom/Gleichstrom-, AC/DC-, Umwandlungseinheit (103) auszugebenden Kompensationsspannung auf Grundlage des aufgezeichneten Gleichspannungssignals, wenn die PID-Effekt-Kompensationsbedingung erfüllt ist; und
Steuern (S104) der Trennungs-AC/DC-Umwandlungseinheit (103) durch die Prozesssteuerungseinheit (102), um die Kompensationsspannung zwischen positiven Elektrodenanschlüssen von fotovoltaischen Modulen und Masse über die Umschaltschutzeinheit (104) anzulegen, um eine PID-Effektkompensation an den fotovoltaischen Modulen durchzuführen;
und **dadurch gekennzeichnet, dass**:

die Umschaltschutzeinheit (104) einen Schutzwiderstand und einen Schnellauslöseschalter aufweist, und
das auf Grundlage des aufgezeichneten Gleichspannungssignals durch die Prozesssteuerungseinheit (102) erfolgende Berechnen (S103) einer durch die Trennungs-AC/DC-Umwandlungseinheit (103) auszugebenden Kompensationsspannung umfasst:
Berechnen (S305), durch die Prozesssteuerungseinheit (102), eines PID-Effekt-Akkumulationswerts der fotovoltaischen Module während der Tageszeit auf Grundlage eines Werts und einer Wirkdauer des aufgezeichneten Gleichspannungssignals, wobei die Wirkdauer einer Dauer entspricht, während der das Gleichspannungssignal größer ist als eine vorgegebene Spannung;
Berechnen (S306) einer Mindestkompensationsspannung für die positiven Elektrodenanschlüsse der fotovoltaischen Module auf Grundlage des PID-Effekt-Akkumulationswerts und eines vorgegebenen Kompensationsparameters, wobei der vorgegebene Kompensationsparameter eine Kompensationszeit und eine Differenz zwischen einem nächtlichen Kompensationsakkumulationswert und dem PID-Effekt-Akkumulationswert aufweist; und
Berechnen (S307) der durch die Trennungs-AC/DC-Umwandlungseinheit (103) auszugebenden Kompensationsspannung auf Grundlage der Mindestkompensationsspannung und einer Spannungsteilungsrelation zwischen dem Schutzwiderstand und der gegenüber Masse bestehenden äquivalenten Isolationsgesamtimpedanz der fotovoltaischen Module.

2. PID-Effekt-Kompensationsverfahren für ein fotovoltaisches Wechselrichtersystem nach Anspruch 1, wobei das durch die Prozesssteuerungseinheit (102) erfolgende Bestimmen (S102) auf Grundlage des Gleichspannungssignals, ob eine PID-Effekt-Kompensationsbedingung erfüllt ist, umfasst:

Bestimmen (S302), durch die Prozesssteuerungseinheit (102), ob das Gleichspannungssignal größer als die vorgegebene Spannung ist;
Bestimmen, durch die Prozesssteuerungseinheit (102), dass es Tag ist, wenn das Gleichspannungssignal größer als die vorgegebene Spannung ist; und
Bestimmen, durch die Prozesssteuerungseinheit (102), dass es Nacht ist und die PID-Effekt-Kompensationsbedingung erfüllt ist, wenn das Gleichspannungssignal kleiner oder gleich der vorgegebenen Spannung ist.

3. PID-Effekt-Kompensationsverfahren für ein fotovoltaisches Wechselrichtersystem nach Anspruch 1 oder 2, wobei vor dem durch die Prozesssteuerungseinheit (102) auf Grundlage des aufgezeichneten Gleichspannungssignals erfolgenden Berechnen (S103) einer durch die Trennungs-AC/DC-Umwandlungseinheit (103) auszugebenden Kompensationsspannung das PID-Effekt-Kompensationsverfahren darüber hinaus umfasst:

Bestimmen (S303), durch die Prozesssteuerungseinheit (102), ob eine gegenüber Masse bestehende äquivalente Isolationsgesamtimpedanz der fotovoltaischen Module größer ist als eine vorgegebene Impedanz, wenn die PID-Effekt-Kompensationsbedingung erfüllt ist; und
Ausgeben (S304) eines Alarmsignals durch die Prozesssteuerungseinheit (102), wenn die gegenüber Masse bestehende äquivalente Isolationsgesamtimpedanz der fotovoltaischen Module kleiner oder gleich der vorgegebenen Impedanz ist, wobei
der durch die Prozesssteuerungseinheit (102) auf Grundlage des aufgezeichneten Gleichspannungssignals erfolgende Schritt des Berechnens (S103) der durch die Trennungs-AC/DC-Umwandlungseinheit (103) auszugebenden Kompensationsspannung durchgeführt wird, wenn die gegenüber Masse bestehende äquivalente Isolationsgesamtimpedanz der fotovoltaischen Module größer als die voreingestellte Impedanz ist.

4. Vorrichtung zur Kompensation eines potentialinduzierten Abbaueffekts bzw. PID-Effekts für ein fotovoltaisches Wechselrichtersystem, aufweisend eine Gleichspannungsabtasteinheit (101), eine Prozesssteuerungseinheit (102), eine Trennungs-Wechselstrom/Gleichstrom-, AC/DC-, Umwandlungseinheit (103), und eine Umschaltschutzeinheit (104), wobei:

Eingangsanschlüsse der Gleichspannungsabtasteinheit (101) an Ausgangsanschlüsse von fotovoltaischen Modulen angeschlossen sind, die Gleichspannungsabtasteinheit (101) dazu ausgelegt ist, ein Gleichspannungssignal an die Prozesssteuerungseinheit (102) auszugeben; ein Eingangsanschluss der Prozesssteuerungseinheit (102) an einen Ausgangsanschluss der Gleichspannungsabtasteinheit (101) angeschlossen ist, Ausgangsanschlüsse der Prozesssteuerungseinheit an einen Steueranschluss der Umschaltschutzeinheit (104) bzw. einen Steueranschluss der Trennungs-AC/DC-Umwandlungseinheit (103) angeschlossen sind, die Prozesssteuerungseinheit (102) dazu ausgelegt ist, auf Grundlage des Gleichspannungssignals zu bestimmen, ob eine PID-Effekt-Kompensationsbedingung erfüllt ist, und auf Grundlage des aufgezeichneten Gleichspannungssignals eine Kompensationsspannung zu berechnen, die durch die Trennungs-AC/DC-Umwandlungseinheit (103) auszugeben ist, wenn die PID-Effekt-Kompensationsbedingung erfüllt ist;
ein Eingangsanschluss der Trennungs-AC/DC-Umwandlungseinheit (103) an ein Stromnetz und ein Ausgangsanschluss der Trennungs-AC/DC-Umwandlungseinheit (103) an einen Eingangsanschluss der Umschaltschutzeinheit (104) angeschlossen ist, wobei die Trennungs-AC/DC-Umwandlungseinheit (103) dazu ausgelegt ist, unter Steuerung der Prozesssteuerungseinheit (102) die Kompensationsspannung auszugeben; und
Ausgangsanschlüsse der Umschaltschutzeinheit (104) an positive Elektrodenanschlüsse der fotovoltaischen Module angeschlossen sind und die Umschaltschutzeinheit (104) dazu ausgelegt ist, die Kompensationsspannung zu übertragen, um die Kompensationsspannung zwischen den positiven Elektrodenanschlüssen der fotovoltaischen Module und Masse anzulegen, um eine PID-Effektkompensation an den fotovoltaischen Modulen durchzuführen;
und **dadurch gekennzeichnet, dass**:

die Umschaltschutzeinheit (104) einen Schutzwiderstand und einen Schnellauslöseschalter aufweist, und
die Prozesssteuerungseinheit (102) dazu ausgelegt ist, um:

einen PID-Effekt-Akkumulationswert der fotovoltaischen Module während der Tageszeit auf Grundlage eines Werts und einer Wirkdauer des aufgezeichneten Gleichspannungssignals zu berechnen, wobei die Wirkdauer einer Dauer entspricht, während der das Gleichspannungssignal größer ist als eine vorgegebene Spannung;
eine Mindestkompensationsspannung für die positiven Elektrodenanschlüsse der fotovoltaischen Module auf Grundlage des PID-Effekt-Akkumulationswerts und eines vorgegebenen Kompensationsparameters zu berechnen, wobei der vorgegebene Kompensationsparameter eine Kompensationszeit und eine Differenz zwischen einem nächtlichen Kompensationsakkumulationswert und dem PID-Effekt-Akkumulationswert aufweist; und
die durch die Trennungs-AC/DC-Umwandlungseinheit (103) auszugebende Kompensationsspannung auf Grundlage der Mindestkompensationsspannung und einer Spannungsteilungsrelation zwischen dem Schutzwiderstand und der gegenüber Masse bestehenden äquivalenten Isolationsgesamtimpedanz der fotovoltaischen Module zu berechnen.

5. PID-Effekt-Kompensationsvorrichtung für ein fotovoltaisches Wechselrichtersystem nach Anspruch 4, wobei
die Gleichspannungsabtasteinheit (101) einen Satz aus verschalteten Dioden mit einer gemeinsamen Kathode und einen Satz aus verschalteten Dioden mit einer gemeinsamen Anode aufweist;
Anoden des Satzes aus verschalteten Dioden mit der gemeinsamen Kathode an die positiven Elektrodenanschlüsse der fotovoltaischen Module in einer Eins-zu-Eins-Entsprechung angeschlossen sind;
Kathoden des Satzes aus verschalteten Dioden mit der gemeinsamen Anode an negative Elektrodenanschlüsse der fotovoltaischen Module in einer Eins-zu-Eins-Entsprechung angeschlossen sind; und
ein gemeinsamer Kathodenverbindungspunkt des Satzes aus verschalteten Dioden mit der gemeinsamen Kathode und ein gemeinsamer Anodenverbindungspunkt des Satzes aus verschalteten Dioden mit der gemeinsamen Anode zwei Ausgangsanschlüsse der Gleichspannungsabtasteinheit (101) darstellen.

6. PID-Effekt-Kompensationsvorrichtung für ein fotovoltaisches Wechselrichtersystem nach Anspruch 4, wobei
die Umschaltschutzeinheit (104) einen Schutzwiderstand R1, einen Schnellauslöseschalter S1 und einen Satz aus verschalteten Dioden mit einer gemeinsamen Anode aufweist;
ein Steueranschluss des Schnellauslöseschalters S1 der Steueranschluss der Umschaltschutzeinheit (104) ist;
der Schutzwiderstand R1 und der Schnellauslöseschalter S1 in Reihe geschaltet sind, um einen Längszweig zu bilden, wobei ein Ende des Längszweigs als Eingangsanschluss der Umschaltschutzeinheit (104) dient und das andere Ende des Längszweigs an einen gemeinsamen Anodenverbindungspunkt des Satzes aus verschalteten Dioden mit der gemeinsamen Anode angeschlossen ist; und
Kathoden des Satzes aus verschalteten Dioden mit der gemeinsamen Anode an die positiven Elektrodenanschlüsse der fotovoltaischen Module in einer Eins-zu-Eins-Entsprechung angeschlossen sind.

7. PID-Effekt-Kompensationsvorrichtung für ein fotovoltaisches Wechselrichtersystem nach Anspruch 4, wobei
ein positiver Gleichstromausgangs-Elektrodenanschluss der Trennungs-AC/DC-Umwandlungseinheit (103) an die Umschaltschutzeinheit angeschlossen ist; und
ein negativer Gleichstromausgangs-Elektrodenanschluss der Trennungs-AC/DC-Umwandlungseinheit (103) auf Masse gelegt ist.

8. Fotovoltaisches Wechselrichtersystem, aufweisend eine Energieumwandlungsvorrichtung (200),
eine Filterungsvorrichtung (300) und
die Vorrichtung (400) zur Kompensation eines potentialinduzierten Abbaueffekts bzw. PID-Effekts nach einem der Ansprüche 4 bis 7, wobei
ein Eingangsanschluss der Energieumwandlungsvorrichtung an ein fotovoltaisches Modul angeschlossen ist;
ein Ausgangsanschluss der Energieumwandlungsvorrichtung an einen Eingangsanschluss der Filterungsvorrichtung angeschlossen ist; und
ein Ausgangsanschluss der Filterungsvorrichtung an ein Stromnetz angeschlossen ist.

9. PID-Effekt-Kompensationsverfahren für ein fotovoltaisches Wechselrichtersystem nach Anspruch 1, wobei das Ausgeben (S101) eines Gleichspannungssignals durch die Gleichspannungsabtasteinheit (101) an die Prozesssteuerungseinheit (102) umfasst:
Ausgeben (S201), durch die Gleichspannungsabtasteinheit (101), nur einer maximalen Ausgangsspannung unter den Ausgangsspannungen aller fotovoltaischen Module als Gleichspannungssignal an die Prozesssteuerungseinheit (102).

Revendications

1. Méthode de compensation d'effet de dégradation induite de potentiel, PID, destinée à un système d'onduleur photovoltaïque, appliquée à un dispositif de compensation d'effet PID destiné au système d'onduleur photovoltaïque, dans laquelle le dispositif de compensation d'effet PID destiné au système d'onduleur photovoltaïque comprend une unité d'échantillonnage de tension continue (101), une unité de commande du traitement (102), une unité de conversion CA/CC d'isolation (103) et une unité de protection de la commutation (104), et la méthode de compensation d'effet PID comprend :

l'émission (S101) par l'unité d'échantillonnage de tension continue (101) d'un signal de tension continue à l'unité de commande du traitement (102) ;
la détermination (S 102) par l'unité de commande du traitement (102) si une condition de compensation d'effet PID est réunie en se basant sur le signal de tension continue ;
le calcul (S103) par l'unité de commande du traitement (102), d'une tension de compensation à émettre par l'unité de conversion courant alternatif/courant continu CA/CC d'isolation (103) en se basant sur le signal de tension continue enregistré si la condition de compensation d'effet PID est réunie ; et
la commande (S104) par l'unité de commande du traitement (102) de l'unité de conversion CA/CC d'isolation (103) afin d'appliquer la tension de compensation entre les bornes d'électrode positive des modules photovoltaïques et la terre via l'unité de protection de la commutation (104), afin de réaliser une compensation d'effet PID sur les modules photovoltaïques ;
et **caractérisée en ce que** :
l'unité de protection de la commutation (104) comprend une résistance de protection et un commutateur de coupure du lancement, et le calcul (S103) par l'unité de commande du traitement (102) d'une tension de compensation à émettre par l'unité de conversion CA/CC d'isolation (103) en se basant sur le signal de tension continue enregistré comprend :

le calcul (S305) par l'unité de commande du traitement (102), d'une valeur d'accumulation d'effet PID des modules photovoltaïques pendant la journée en se basant sur une valeur et une durée d'action du signal de tension continue enregistré, dans lequel

la durée d'action est une durée lorsque le signal de tension continue est supérieur à une tension prédéfinie ;
le calcul (S306) d'une tension de compensation minimum pour les bornes d'électrode positives des modules photovoltaïques en se basant sur la valeur d'accumulation d'effet PID et un paramètre de compensation prédéfini, dans lequel le paramètre de compensation prédéfini comprend un temps de compensation et une différence entre une valeur d'accumulation de compensation de nuit et la valeur d'accumulation d'effet PID ; et
le calcul (S307) de la tension de compensation à émettre par l'unité de conversion CA/CC d'isolation (103) en se basant sur la tension de compensation minimum et une relation de division de tension entre la résistance de protection et l'impédance d'isolation équivalente totale à la terre des modules photovoltaïques.

2. Méthode de compensation d'effet PID destinée à un système d'onduleur photovoltaïque selon la revendication 1, dans laquelle la détermination (S102) par l'unité de commande du traitement (102) si une condition de compensation d'effet PID est réunie en se basant sur le signal de tension continue comprend :

la détermination (S302) par l'unité de commande du traitement (102) si le signal de tension continue est supérieur à la tension prédéfinie ;
la détermination par l'unité de commande du traitement (102) que c'est la journée, si le signal de tension continue est supérieur à la tension prédéfinie ; et
la détermination par l'unité de commande du traitement (102) que c'est la nuit et que la condition de compensation d'effet PID est réunie si le signal de tension continue est inférieur ou égal à la tension prédéfinie.

3. Méthode de compensation d'effet PID destinée à un système d'onduleur photovoltaïque selon les revendications 1 ou 2, dans laquelle, avant le calcul (S103) par l'unité de commande du traitement (102) d'une tension de compensation à émettre par l'unité de conversion CA/CC d'isolation (103) en se basant sur le signal de tension continue enregistré, dans laquelle la méthode de compensation d'effet PID comprend par ailleurs :

la détermination (S303) par l'unité de commande du traitement (102) si une impédance d'isolation équivalente totale à la terre des modules photovoltaïques est supérieure à une impédance prédéfinie, si la condition de compensation d'effet PID est réunie ; et
l'émission (S304) par l'unité de commande du traitement (102) d'un signal d'alarme si l'impédance d'isolation équivalente totale à la terre des modules photovoltaïques est inférieure ou égale à l'impédance prédéfinie, dans laquelle
l'étape de calcul (S103) par l'unité de commande du traitement (102) d'une tension de compensation à émettre par l'unité de conversion CA/CC d'isolation (103) en se basant sur le signal de tension continue enregistré est réalisée si l'impédance d'isolation équivalente totale à la terre des modules photovoltaïques est supérieure à l'impédance prédéfinie.

4. Dispositif de compensation d'effet de dégradation induite de potentiel, PID, destiné à un système d'onduleur photovoltaïque, comprenant
une unité d'échantillonnage de tension continue (101),
une unité de commande du traitement (102),
une unité de conversion courant alternatif/courant continu CA/CC d'isolation (103) et
une unité de protection de la commutation (104), dans laquelle :

des bornes d'entrée de l'unité d'échantillonnage de tension continue (101) sont connectées à des bornes de sortie des modules photovoltaïques, l'unité d'échantillonnage de tension continue (101) est configurée pour émettre un signal de tension continue à l'unité de commande du traitement (102) ;
une borne d'entrée de l'unité de commande du traitement (102) est connectée à une borne de sortie de l'unité d'échantillonnage de tension continue (101), des bornes de sortie de l'unité de commande du traitement sont respectivement connectées à une borne de commande de l'unité de protection de la commutation (104) et à une borne de commande de l'unité de conversion CA/CC d'isolation (103), l'unité de commande du traitement (102) est configurée pour déterminer si une condition de compensation d'effet PID est réunie en se basant sur le signal de tension continue, et calculer une tension de compensation à émettre par l'unité de conversion CA/CC d'isolation (103) se basant sur le signal de tension continue enregistré si la condition de compensation d'effet PID est réunie ;
une borne d'entrée de l'unité de conversion CA/CC d'isolation (103) est connectée à un réseau électrique et une borne de sortie de l'unité de conversion CA/CC d'isolation (103) est connectée à une borne d'entrée de l'unité de protection de la commutation (104), l'unité de conversion CA/CC d'isolation (103) est configurée pour émettre la tension de compensation sous

commande de l'unité de commande du traitement (102) ; et
des bornes de sortie de l'unité de protection de la commutation (104) sont connectées à des bornes d'électrode positives des modules photovoltaïques, et l'unité de protection de la commutation (104) est configurée afin de transférer la tension de compensation pour appliquer la tension de compensation entre les bornes d'électrode positives des modules photovoltaïques et la terre, afin de réaliser la compensation d'effet PID sur les modules photovoltaïques ;
et **caractérisé en ce que** :

l'unité de protection de la commutation (104) comprend une résistance de protection et un commutateur de coupure du lancement, et
l'unité de commande du traitement (102) est configurée pour :

calculer une valeur d'accumulation d'effet PID des modules photovoltaïques pendant la journée en se basant sur une valeur et une durée d'action du signal de tension continue enregistré, dans lequel la durée d'action est une durée lorsque le signal de tension continue est supérieur à une tension prédéfinie ;
calculer une tension de compensation minimum pour les bornes d'électrode positives des modules photovoltaïques en se basant sur la valeur d'accumulation d'effet PID et un paramètre de compensation prédéfini, dans lequel le paramètre de compensation prédéfini comprend un temps de compensation et une différence entre une valeur d'accumulation de compensation de nuit et la valeur d'accumulation d'effet PID ; et
calculer la tension de compensation à émettre par l'unité de conversion CA/CC d'isolation (103) en se basant sur la tension de compensation minimum et une relation de division de tension entre la résistance de protection et l'impédance d'isolation équivalente totale à la terre des modules photovoltaïques.

5. Dispositif de compensation d'effet PID destiné à un système d'onduleur photovoltaïque selon la revendication 4, dans lequel :

l'unité d'échantillonnage de tension continue (101) comprend un jeu de diodes connectées avec une cathode commune et un jeu de diodes connectées avec une anode commune ;
des anodes du jeu de diodes connectées avec la cathode commune sont connectées aux bornes d'électrode positives des modules photovoltaïques en correspondance biunivoque ;
des cathodes du jeu de diodes connectées avec l'anode commune sont connectées aux bornes d'électrode négatives des modules photovoltaïques en correspondance biunivoque ; et
un point de connexion de cathode commune du jeu de diodes connectées avec la cathode commune et un point de connexion d'anode commune du jeu de diodes connectées avec l'anode commune sont deux bornes de sortie de l'unité d'échantillonnage de tension continue (101).

6. Dispositif de compensation d'effet PID destiné à un système d'onduleur photovoltaïque selon la revendication 4, dans lequel :

l'unité de protection de la commutation (104) comprend une résistance de protection R1, un commutateur de coupure du lancement S1 et un jeu de diodes connectées avec une anode commune ;
une borne de commande du commutateur de coupure du lancement S1 est la borne de commande de l'unité de protection de la commutation (104) ;
la résistance de protection R1 et le commutateur de coupure du lancement S1 sont connectés en série afin de former une branche de série, une extrémité de la branche de série sert de borne d'entrée de l'unité de protection de la commutation (104) et l'autre extrémité de la branche de série est connectée à un point de connexion d'anode commune du jeu de diodes connectées avec l'anode commune ; et
des cathodes du jeu de diodes connectées avec l'anode commune sont connectées aux bornes d'électrode positives des modules photovoltaïques en correspondance biunivoque.

7. Dispositif de compensation d'effet PID destiné à un système d'onduleur photovoltaïque selon la revendication 4, dans lequel :

une borne d'électrode positive à sortie de courant continu de l'unité de conversion CA/CC d'isolation (103) est connectée à l'unité de protection de la commutation ; et
une borne d'électrode négative à sortie de courant continu de l'unité de conversion CA/CC d'isolation (103) est mise à la terre.

8. Système d'onduleur photovoltaïque comprenant
un dispositif de conversion d'énergie (200),
un dispositif de filtrage (300), et

le dispositif de compensation d’effet de dégradation induite de potentiel, PID (400) selon une quelconque des revendications 4 à 7, dans lequel :

une borne d’entrée du dispositif de conversion d’énergie est connectée à un module photovoltaïque ;
une borne de sortie du dispositif de conversion d’énergie est connectée à une borne d’entrée du dispositif de filtrage ; et
une borne de sortie du dispositif de filtrage est connectée à un réseau électrique.

9. Méthode de compensation d’effet PID destinée à un système d’onduleur photovoltaïque selon la revendication 1, dans laquelle l’émission (S101) par l’unité d’échantillonnage de tension continue (101) d’un signal de tension continue à l’unité de commande du traitement (102) comprend :
l’émission (S201) par l’unité d’échantillonnage de tension continue (101) de seulement une tension de sortie maximum parmi les tensions de sortie de tous les modules photovoltaïques en tant que le signal de tension continue, à l’unité de commande du traitement (102).

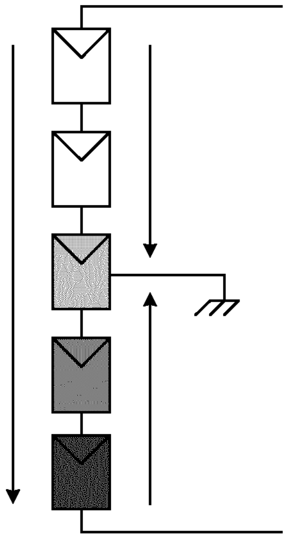


Figure 1

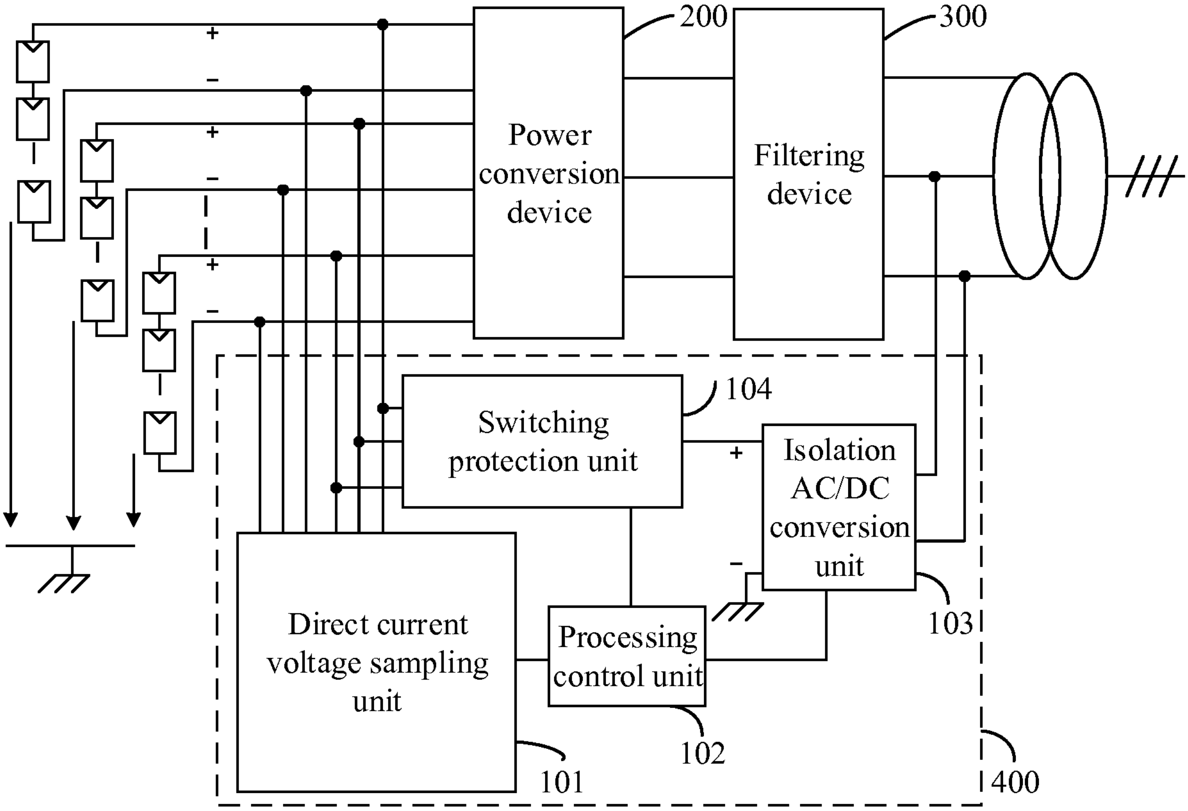


Figure 2

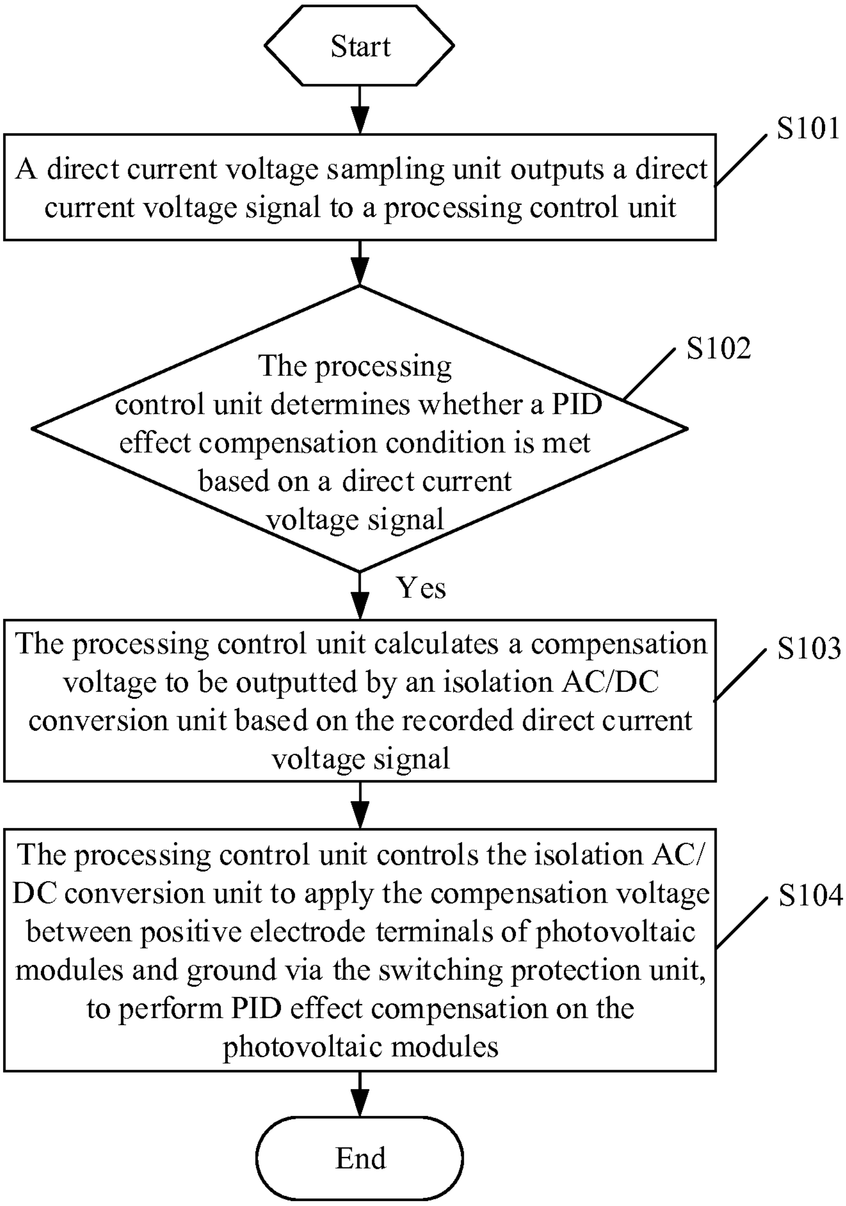

Start
A direct current voltage sampling unit outputs a direct current voltage signal to a processing control unit
S101
The processing control unit determines whether a PID effect compensation condition is met based on a direct current voltage signal
S102
Yes
The processing control unit calculates a compensation voltage to be outputted by an isolation AC/DC conversion unit based on the recorded direct current voltage signal
S103
The processing control unit controls the isolation AC/DC conversion unit to apply the compensation voltage between positive electrode terminals of photovoltaic modules and ground via the switching protection unit, to perform PID effect compensation on the photovoltaic modules
S104
End

Figure 3

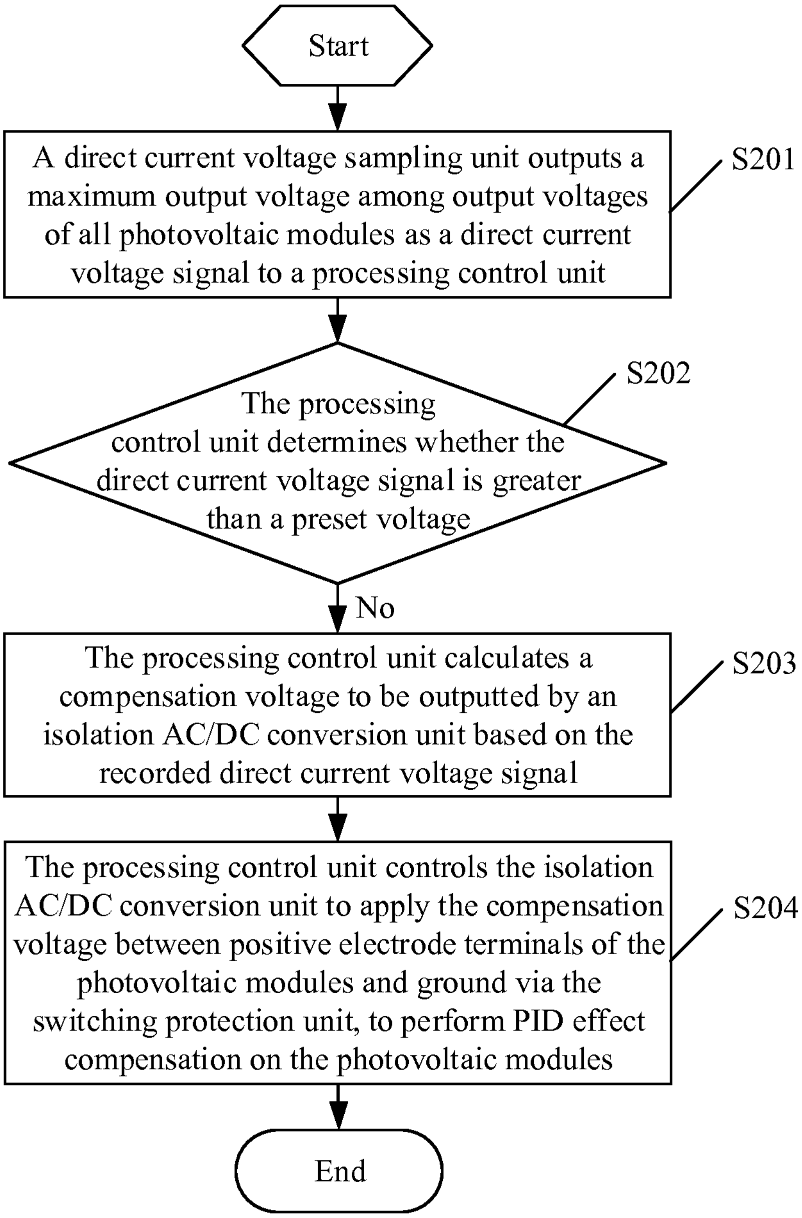

Start
A direct current voltage sampling unit outputs a maximum output voltage among output voltages of all photovoltaic modules as a direct current voltage signal to a processing control unit
S201
The processing control unit determines whether the direct current voltage signal is greater than a preset voltage
S202
No
The processing control unit calculates a compensation voltage to be outputted by an isolation AC/DC conversion unit based on the recorded direct current voltage signal
S203
The processing control unit controls the isolation AC/DC conversion unit to apply the compensation voltage between positive electrode terminals of the photovoltaic modules and ground via the switching protection unit, to perform PID effect compensation on the photovoltaic modules
S204
End

Figure 4

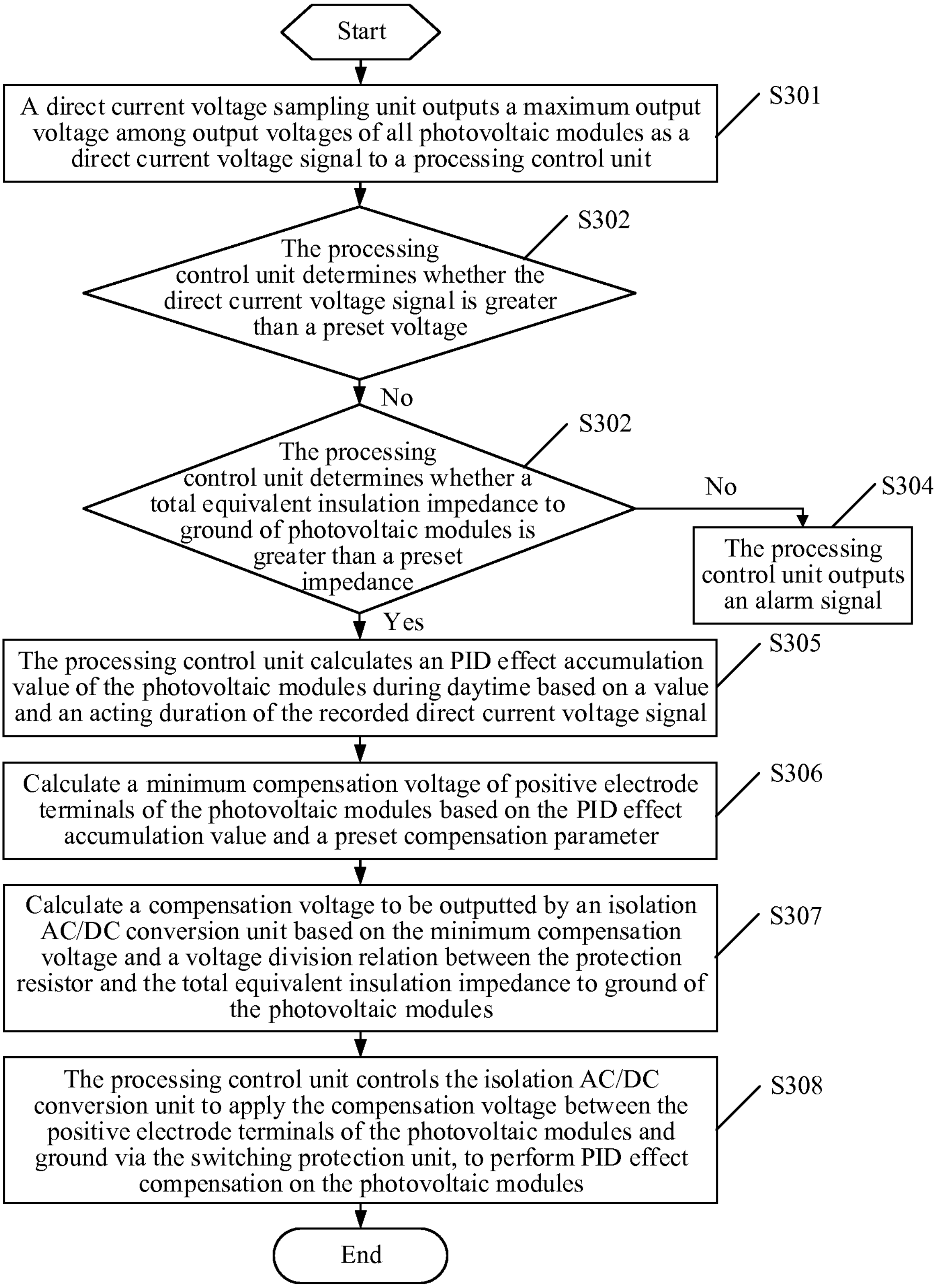
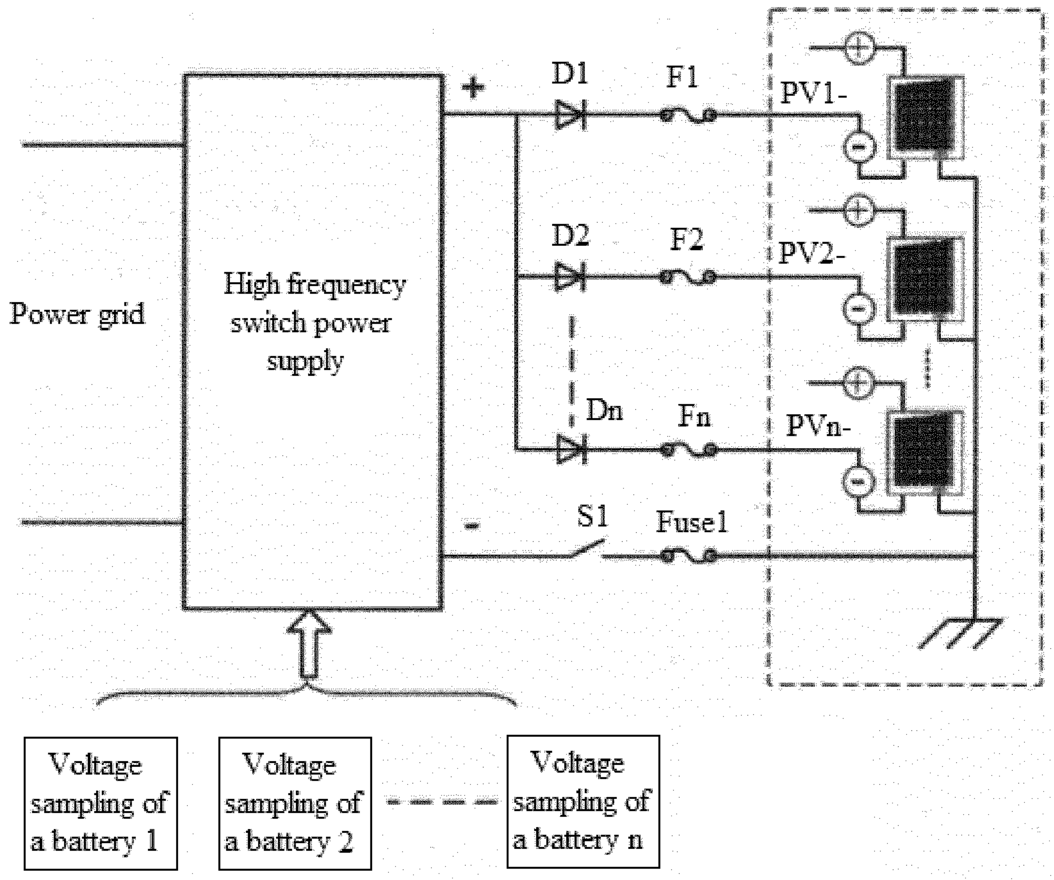

Start
A direct current voltage sampling unit outputs a maximum output voltage among output voltages of all photovoltaic modules as a direct current voltage signal to a processing control unit
S301
The processing control unit determines whether the direct current voltage signal is greater than a preset voltage
S302
No
The processing control unit determines whether a total equivalent insulation impedance to ground of photovoltaic modules is greater than a preset impedance
S302
No
S304
The processing control unit outputs an alarm signal
Yes
The processing control unit calculates an PID effect accumulation value of the photovoltaic modules during daytime based on a value and an acting duration of the recorded direct current voltage signal
S305
Calculate a minimum compensation voltage of positive electrode terminals of the photovoltaic modules based on the PID effect accumulation value and a preset compensation parameter
S306
Calculate a compensation voltage to be outputted by an isolation AC/DC conversion unit based on the minimum compensation voltage and a voltage division relation between the protection resistor and the total equivalent insulation impedance to ground of the photovoltaic modules
S307
The processing control unit controls the isolation AC/DC conversion unit to apply the compensation voltage between the positive electrode terminals of the photovoltaic modules and ground via the switching protection unit, to perform PID effect compensation on the photovoltaic modules
S308
End

Figure 5



Power grid
High frequency switch power supply
+
-
D1
D2
Dn
F1
F2
Fn
S1
Fuse1
PV1-
PV2-
PVn-
Voltage sampling of a battery 1
Voltage sampling of a battery 2
Voltage sampling of a battery n

Figure 6

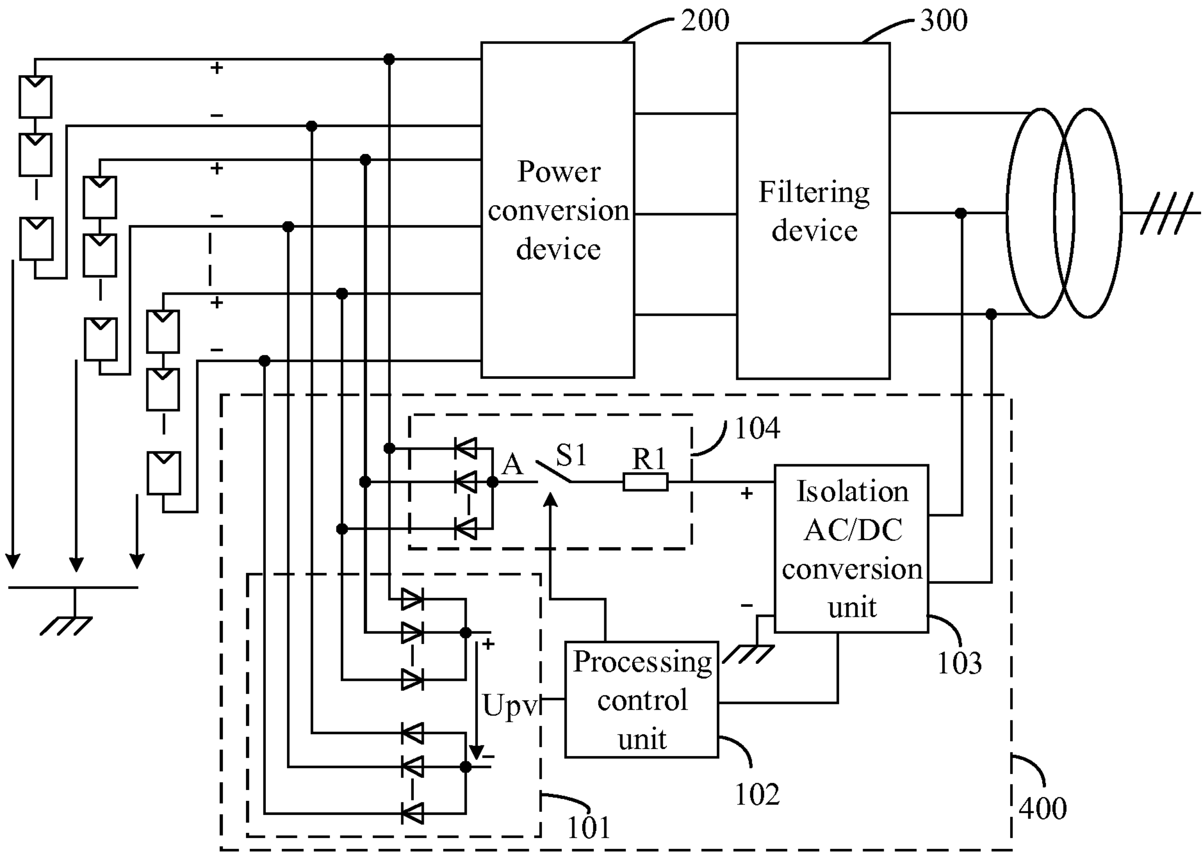

200
300
Power conversion device
Filtering device
104
A
S1
R1
Isolation AC/DC conversion unit
103
Processing control unit
102
Upv
101
400
+
–
+
–
+
–

Figure 7

REFERENCES CITED IN THE DESCRIPTION

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